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(54) CUTTING LIQUID, ITS MANUFACTURE AND CUTTING METHOD OF INGOT

(57)Abstract:
PURPOSE: To solve a risk of ignition at the time of making use of nonwater- soluble cutting oil and a problem of air polution by an organinc solvent by following a washing process of a material to be cut and reduce a warp of a sliced product at the time of cutting-off of an ingot such as a large-diameter silicon single crystal.
CONSTITUTION: A uniform mixture with a fatty acid amine which is comprised by making organic and /or inorganic bentonite, water, an alkanolamine and a higher fatty acid react on each other is taken as a main component and the main component is made into a water-soluble cutting liquid by adding an auxiliary agent such as a water retention improver, a lowering agent of a friction coefficient, the auxiliary agent of rust preventive capacity, washing property improving auxiliary agent and a defoaming agent.

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(54)【発明の名称】　切削液、その製造方法およびインゴットの切断方法

(57)【要約】

【目的】　非水溶性切削油を用いた場合における引火の危険性や、被切削材洗浄工程に伴う有機溶剤による大気汚染問題を解決するとともに、大径のシリコン単結晶等のインゴットを切断するときのスライス品の反りを低下させる。

【構成】　有機および／または無機ベントナイトと、水と、アルカノールアミンと高級脂肪酸とを反応させてなる脂肪酸アミンとの均一混合物を主成分とし、この主成分に保水性向上剤、洗浄性向上剤、摩擦係数低下剤、防錆力補助剤、洗浄性向上補助剤および消泡剤等の補助剤を添加することにより水溶性切削液とする。

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【特許請求の範囲】

【請求項１】　有機ベントナイトまたは無機ベントナイトの少なくとも一方と、水と、アルカノールアミンと高級脂肪酸とを反応させてなる脂肪酸アミンとの均一混合物を主成分として含有することを特徴とする切削液。

【請求項２】　前記主成分と、保水性向上剤、洗浄性向上剤、摩擦係数低下剤、防錆力補助剤、洗浄性向上補助剤および消泡剤からなる群より任意に選ばれた一種または複数種の補助剤とからなることを特徴とする請求項１に記載の切削液。

【請求項３】　請求項１に記載の切削液を製造するに際し、水に有機ベントナイトまたは無機ベントナイトの少なくとも一方を添加して保潤分散させ、該分散液にアルカノールアミンを添加してアルカリ性となし、さらに該分散液に高級脂肪酸を添加し、該高級脂肪酸とアルカノールアミンとを反応させて脂肪酸アミンとなすことを特徴とする切削液の製造方法。

【請求項４】　請求項１または２に記載の切削液に砥粒を分散させた分散液を切削剤（スラリー）として用い、ワイヤソーまたはバンドソーにより、シリコン単結晶等のインゴットをスライスすることを特徴とするインゴットの切断方法。

【発明の詳細な説明】

【０００１】

【産業上の利用分野】本発明は、シリコン単結晶や多結晶、その他化合物半導体やセラミック等のインゴットの切断用に有効な切削液（水溶性切削液）、その製造方法およびこの切削液を用いるインゴットの切断方法に関する。

【０００２】

【従来の技術】従来、シリコン単結晶等のインゴット切断用の切削液としては、主に、鉱物油を主成分とする非水溶性切削油が用いられており、この切削油にＳｉＣ等の砥粒を混合・分散させた切削剤（スラリー）をインゴットの切断部に供給することにより、インゴットのスライスが行われている。そして、このスライス品は、洗浄工程を経て次工程に供される。また、インゴットの切断に用いられた後のスラリーは、廃棄物として処理されている。

【０００３】前記スライス品の洗浄は、これに付着する切削油等を除去するものであり、従来、洗浄液として有機溶剤系のもの（例えばトリクロロエタン、塩化メチレン等）が用いられてきた。この有機溶剤系の洗浄液によれば、洗浄作業が簡単になる利点がある。

【０００４】また、上記インゴット切断用の加工具としては外周刃、内周刃、バンドソーまたはワイヤソーが用いられている。この場合、直径３インチ以上の比較的大径のインゴットの切断には、ワイヤソーやバンドソーが多用されるようになっている。その理由は他の加工具に比べて、より均一厚さでインゴットをスライスすることができ、切断屑の発生量が少なくてすむだけでなく、一度に多数枚のウエーハを切断することができるからである。

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【０００５】

【発明が解決しようとする課題】しかし、鉱物油を主成分とする切削油は、引火性のある危険物であり、上記有機溶剤系の洗浄液は、発ガンや大気汚染（オゾン層の破壊）の主原因になるため最近、使用が禁止されている。また、前記スラリーは切断に供された後、廃棄物として焼却処理されるのが一般的であり、この焼却も大気汚染の一原因になっている。このため、その代替品の開発が待たれていた。

【０００６】さらに、インゴット切断の場合においては、切断速度の増大とともに得られたスライス品に「反り」が発生（スライス品の中央部が凸状になる）しやすくなり、ワイヤソーの場合では、直径６インチのシリコン単結晶インゴットを切断速度１ｍｍ／ｍｉｎ以上で切断すると、反りが１０μｍを超えることがあり、このような大きな反りは、シリコンウエーハ等を製造加工する時の障害になると共に、結果として、その歩留りが低下する原因にもなっている。

【０００７】本発明は、切削液を水溶性とすることにより、上記従来の問題点を解決したものである。すなわち本発明の目的は、従来の非水溶性切削油を用いる場合における引火の危険性や、被切削材洗浄工程における有機溶剤の使用に伴う大気汚染等の諸問題を解決するとともに、大径のシリコン単結晶インゴット等を切断するときのスライス品の反りを低下させることにある。

【０００８】

【課題を解決するための手段】請求項１に記載の切削液は、有機ベントナイトまたは無機ベントナイトの少なくとも一方と、水と、アルカノールアミンと高級脂肪酸とを反応させてなる脂肪酸アミンとの均一混合物を主成分として含有することを特徴とする。

【０００９】請求項２に記載の切削液は、請求項１において前記主成分と、保水性向上剤、洗浄性向上剤、摩擦係数低下剤、防錆力補助剤、洗浄性向上補助剤および消泡剤からなる群より任意に選ばれた一種または複数種の補助剤とからなることを特徴とする。

【００１０】請求項３に記載の切削液の製造方法は、請求項１に記載の切削液を製造するに際し、水に有機ベントナイトまたは無機ベントナイトの少なくとも一方を添加して保潤分散させ、該分散液にアルカノールアミンを添加してアルカリ性となし、さらに該分散液に高級脂肪酸を添加し、該高級脂肪酸とアルカノールアミンとを反応させて脂肪酸アミンとなすことを特徴とする。

【００１１】請求項４に記載のインゴットの切断方法は、請求項１または２に記載の切削液に砥粒を分散させた分散液を切削剤（スラリー）として用い、ワイヤソーまたはバンドソーによりシリコン単結晶等のインゴット

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をスライスすることを特徴とする。

【００１２】本発明の切削液はベントナイトと、水と、アルカノールアミンと高級脂肪酸とを反応させてなる脂肪酸アミンとを、必須の構成成分として含有するものであり、一般的に下記の主原料と各種補助剤との組合せにより構成される。

（Ａ）無機・有機ベントナイト（主原料）：架橋性の分散性向上剤（沈降防止剤）であって、砥粒の分散性を向上させるためのものである。

（Ｂ）アルカノールアミン（主原料）：この切削液の主原料であると同時に、防錆力補助剤としても作用する。通常、分子量１４０以上のものとして、ここではトリエタノールアミンを使用した。

（Ｃ）高級脂肪酸（主原料）：この切削液の主原料であると同時に摩擦係数低下剤（潤滑性向上剤）としても作用する。通常、不飽和脂肪酸の含有量９０重量％以上のものが用いられ、ここではオレイン酸を使用した。

（Ｄ）保水性向上剤：この切削液の保水性向上剤および潤滑性を補足するための補助剤として作用する。例えば、ポリアルキレングリコール高分子重合体が用いられ、一般的には分子量１５，０００～３０，０００の重合体が好ましい。

（Ｅ）洗浄性向上剤：この洗浄性向上剤は砥粒の分散性向上用の補助剤としても作用する。例えば、ポリエチレングリコールブロックポリマーが用いられ、通常、分子量４０～６０のものが用いられる。

（Ｆ）摩擦係数低下剤：上記（Ｃ）高級脂肪酸が摩擦係数低下剤としても作用する。

（Ｇ）防錆力補助剤：例えば、ベンゾトリアゾール（トリルトリアゾール）を使用する。分子量は１１０～１４０のものが好ましい。

（Ｈ）洗浄性向上補助剤：グリコールエーテルとして、例えばトリプロピレングリコールモノメチルエーテルが用いられる。

（Ｉ）消泡剤：前記成分（Ｄ）（Ｅ）の発泡性を抑えるもので、シリコーン樹脂系のものを使用した。

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（Ｊ）精製水（主原料）：各原料をイオン化するためのイオン化溶媒として作用する。

【００１３】本発明の切削液は、以下の手順で製造される。すなわち、精製水（例えばイオン交換水）に無機および／または有機ベントナイトを添加して十分保潤・分散させ、この分散液にアルカノールアミンを添加して、この分散液をアルカリ性とすることにより、前記ベントナイトの分散状態を更に均一化する。次に、高級脂肪酸を添加してアルカノールアミンと反応させて脂肪酸アミンを形成させる。この反応が十分進行した後、前記保水性向上剤、洗浄性向上剤、摩擦係数低下剤、防錆力補助剤、洗浄性向上補助剤および消泡剤等のうちから任意に一種または複数種を選んで添加して完成品とする。

【００１４】従来、水溶性切削液自体は公知であるが、従来のものでは表面張力が高くて浸透性に劣るうえ、摩擦係数が高くて潤滑性が十分でない。また、防錆力も不足しているだけでなく、液分が蒸発しやすいという欠点があった。これに対し、本発明の水溶性切削液は、それぞれの構成成分の潜在的特性を活かすことにより、上記従来のものの欠点を解消するとともに、構成成分の一つである脂肪酸の長所であり、かつ短所でもある起泡性を、脂肪酸アミンに変化させることで解消した点に、特徴の一つがある。

【００１５】本発明の切削液は、これに砥粒を混合・分散させて用いられ、シリコン単結晶または多結晶からなるインゴットの切断用に特に有効であるが、化合物半導体あるいはセラミック等々の切断にも広く使用することができる。また、この切削液が用いられる切断装置としては、ワイヤソーやバンドソー、これらを多重化したマルチワイヤソーやマルチバンドソーが含まれる。更には外周刃や内周刃の切断装置にも転用が可能である。

【００１６】実際に製造され、使用に供される本発明の切削液の原料成分およびその組成は、標準的には［表１］に示すとおりである。

【００１７】

【表１】

成分		重量％
（A）無機および／または有機ベントナイト		1.0 ～2.0
（B）アルカノールアミン	トリエタノールアミン	4.0～6.0
（C）高級脂肪酸	オレイン酸	5.0～8.0
（D）保水性向上剤	ポリアルキレングリコール高分子重合体	22.0～26.0
（E）洗浄性向上剤・分散剤	ポリエチレングリコールブロックポリマー	3.0～5.0
（F）摩擦係数低下剤	特に添加せず（高級脂肪酸がその機能を有す）	―――
（G）防錆力補助剤	ベンゾトリアゾール	0.1 ～0.3
（H）洗浄性向上補助剤	トリプロピレングリコールモノメチルエーテル	3.0 ～5.5
（I）消泡剤	シリコーン樹脂系	0.01～0.1
（J）精製水		55.0～60.0

【００１８】

【実施例】つぎに本発明の実施例と、従来の切削油による比較例について説明する。

実施例１および比較例１

この実施例の切削液（１）を構成する原料成分および割合は、［表２］に示すとおりである。

【００１９】

【表２】

成分		重量%
（A）無機および／または有機ベントナイト		1.63
（B）アルカノールアミン	トリエタノールアミン	4.70
（C）高級脂肪酸	オレイン酸	6.10
（D）保水性向上剤	ポリアルキレングリコール高分子重合体	25.34
（E）洗浄性向上剤・分散剤	ポリエチレングリコールブロックポリマー	4.08
（F）摩擦係数低下剤	特に添加せず（高級脂肪酸がその機能を有す）	―――
（G）防錆力補助剤	ベンゾトリアゾール	0.21
（H）洗浄性向上補助剤	トリプロピレングリコールモノメチルエーテル	4.08
（I）消泡剤	シリコーン樹脂系	0.01
（J）精製水		53.85
合計		100.00

【００２０】上記本発明の水溶性切削液（１）と従来例の非水溶性切削油（２）の物性を示すと、［表３］のとおりである。

【００２１】
【表３】

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	切削液（１）（本発明）	切削油（２）（従来例）
比重　２５℃	１．０２８±３％	０．８９４
粘度　２５℃（m・Ｐａ・Ｓ）	１１５±３％	８０～１００
ＰＨ　２５℃	８．７２±３％	—
表面張力（ｄｙｎ／ｃｍ）	３２．０±３％	３１．８
引火点（℃）（クリーブランド開放式）	なし（１００℃で沸騰）	１６６±１０
摩擦係数	０．１０５～０．１０６	０．０９２～０．１００

【００２２】上記切削液（１），切削油（２）と砥粒（ＳｉＣ砥粒であり、ＧＣ＃６００、平均砥粒径１９～２０μｍ）を１．０～１．５リットル：１．５ｋｇの割合で混合・分散させたスラリーを用い、線径が０．１８ｍｍのマルチワイヤソーの張力を３．０ｋｇｆとし、シリコン単結晶のインゴットを切断速度１ｍｍ／ｍｉｎで、肉厚０．７５ｍｍのスライス品に切断した。

【００２３】その結果、実施例１の切削液（１）を用いた場合、直径６インチのインゴットでは、スライス品の反り（凸状に変形した中央部と、外周部との高さの差の最大値）は、すべて１０μｍ以下となり、直径８インチのインゴットでは、スライス品の反りは１００枚の全てが２０μｍ以下となった。これに対し、比較例１の切削油（２）を用いた場合、直径６インチのインゴットでは、スライス品の反りは１００枚中、９８枚が１０μｍ以下となり、直径８インチのインゴットでは、スライス品の反りは１００枚中、９８枚が２０μｍ以下となった。このように、本発明の水溶性切削液によって、従来の非水溶性切削油と同等の切断結果を得ることができた。

【００２４】

【発明の効果】以上の説明で明らかなように、本発明の切削液によれば、大径のシリコン単結晶等のインゴットを、従来の切削油の場合と同等に高速で、かつスライス品に大きな反りを発生させることなく切断することができる効果がある。また、本発明の切削液は水溶性であるから引火による火災の危険性はなく、得られたスライス品に付着する切削液の洗浄を水洗により行うことができて好都合である。また、洗浄排水の処理では、既設の排水設備を利用することが可能であり、切断に供したスラリーの処理も同様に行うことができるため、従来の有機溶媒系の洗浄液を用いる場合と異なり大気汚染を引き起こす心配もなくなるなどの効果がある。

フロントページの続き

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CLAIMS

[Claim(s)]
[Claim 1] Cutting fluid characterized by containing a homogeneous mixture with the fatty-acid amine to which either [at least] organic bentonite or an inorganic bentonite water, and alkanolamine and a higher fatty acid are made to come to react as a principal component.
[Claim 2] Cutting fluid according to claim 1 characterized by consisting of a kind or two or more sorts of adjuvants chosen as arbitration from the group which serves as said principal component from a water retention improver, a washing disposition top agent, a coefficient-of-friction fall agent, a rust-proofing force adjuvant, a washing disposition top adjuvant, and a defoaming agent.
[Claim 3] The manufacture approach of the cutting fluid which faces manufacturing cutting fluid according to claim 1, adds either [at least] organic bentonite or an inorganic bentonite in water, is made to carry out **** distribution, adds alkanolamine to these dispersion liquid and is characterized by alkalinity, nothing, and adding a higher fatty acid to these dispersion liquid further, making this higher fatty acid and alkanolamine react, and making with a fatty-acid amine.
[Claim 4] Cutting process of the ingot characterized by slicing ingots, such as a silicon single crystal, by the wire saw or the band saw, using the dispersion liquid which made cutting fluid according to claim 1 or 2 distribute an abrasive grain as a cutting fluid (slurry).

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to cutting fluid (water-soluble cutting fluid) effective in cutting of ingots, such as a silicon single crystal, polycrystal, other compound semiconductors, and a ceramic, its manufacture approach, and the cutting process of the ingot using this cutting fluid.
[0002]
[Description of the Prior Art] Conventionally, as cutting fluid for ingot cutting of a silicon single crystal etc., the nonaqueous solubility cutting oil which uses straight mineral oil as a principal component is mainly used, and the slice of an ingot is performed by supplying the cutting fluid (slurry) which made this cutting oil mix and distribute abrasive grains, such as SiC, to the cutting section of an ingot. And degree process is presented with this slice article through a washing process. Moreover, Ushiro's slurry used for cutting of an ingot is processed as trash.
[0003] Washing of said slice article removes the cutting oil adhering to this etc., and the things (for example, trichloroethane, a methylene chloride, etc.) of an organic solvent system have been conventionally used as a penetrant remover. According to the penetrant remover of this organic solvent system, there is an advantage to which washing becomes easy.
[0004] Moreover, as a processing implement for the above-mentioned ingot cutting, the peripheral cutting edge, the inner circumference cutting edge, the band saw, or the wire saw is used. in this case, the diameter of 3 inches or more -- a wire saw and a band saw are comparatively used abundantly at cutting of the ingot of a major diameter. the processing implement of others [reason / the] -- comparing -- more -- homogeneity thickness -- an ingot -- being sliceable -- the yield of cutting waste -- being few -- not only ending -- at once -- many -- it is because several wafers can be cut.

[0005]
[Problem(s) to be Solved by the Invention] However, the cutting oil which uses straight mineral oil as a principal component is the dangerous substance with inflammability, and since the penetrant remover of the above-mentioned organic solvent system becomes the cause of main of a ** gun or air pollution (destruction of an ozone layer), use is forbidden recently. Moreover, as for said slurry, it is common that incineration processing is carried out as trash after cutting is presented, and this incineration also causes [one] air pollution. For this reason, it waited for development of that substitute.
[0006] Furthermore, become easy to generate "curvature" in the slice article which was obtained with increase of cutting speed in ingot cutting (the center section of the slice article becomes convex). In the case of a wire saw, when a silicon single crystal ingot with a diameter of 6 inches is cut with 1 or more mm/min of cutting speed, curvature may exceed 10 micrometers. Such big curvature While becoming a failure when carrying out manufacture processing of the silicon wafer etc., it is also the cause that the yield falls, as a result.
[0007] This invention solves the above-mentioned conventional trouble by making cutting fluid into water solubility. That is, the purpose of this invention is to reduce the curvature of the slice article when cutting the silicon single crystal ingot of a major diameter etc. while solving many problems, such as the danger of ignition in the case of using conventional nonaqueous solubility cutting oil, and air pollution accompanying use of the organic solvent in a cut material washing process.
[0008]
[Means for Solving the Problem] Cutting fluid according to claim 1 is characterized by containing a homogeneous mixture with the fatty-acid amine to which at least organic bentonite or an inorganic bentonite either water, and alkanolamine and a higher fatty acid are made to come to react as a principal component.
[0009] Cutting fluid according to claim 2 is characterized by consisting of a kind or two or more sorts of adjuvants chosen as arbitration from the group which serves as said principal component from a water retention improver, a washing disposition top agent, a coefficient-of-friction fall agent, a rust-proofing force adjuvant, a washing disposition top adjuvant, and a defoaming agent in claim 1.
[0010] It faces manufacturing cutting fluid according to claim 1, either [at least] organic bentonite or an inorganic bentonite is added in water, **** distribution is carried out, and the manufacture approach of cutting fluid according to claim 3 adds alkanolamine to these dispersion liquid, and is characterized by alkalinity, nothing, and adding a higher fatty acid to these dispersion liquid further, making this higher fatty acid and alkanolamine react, and making with a fatty-acid amine.
[0011] Cutting process of an ingot according to claim 4 is characterized by slicing ingots,

such as a silicon single crystal, by the wire saw or the band saw, using the dispersion liquid which made cutting fluid according to claim 1 or 2 distribute an abrasive grain as a cutting fluid (slurry).

[0012] The cutting fluid of this invention contains the fatty-acid amine to which make a bentonite, water, and alkanolamine and a higher fatty acid come to react as an indispensable constituent, and, generally is constituted by the combination of the following main raw material and various adjuvants.

(A) -- inorganic and organic bentonite (main raw material): -- it is the dispersibility improver (sedimentation inhibitor) of cross-linking, and is for raising the dispersibility of an abrasive grain.

(B) Alkanolamine (the main raw material) : while it is the main raw material of this cutting fluid, act also as a rust-proofing force adjuvant. Usually, triethanolamine was used as a with a molecular weight of 140 or more thing here.

(C) Higher fatty acid (the main raw material) : while it is the main raw material of this cutting fluid, act also as a coefficient-of-friction fall agent (lubrication disposition top agent). Usually, the thing of 90 % of the weight or more of contents of unsaturated fatty acid was used, and oleic acid was used here.

(D) Water retention improver : act as an adjuvant for supplementing with the water retention improver of this cutting fluid, and lubricity. For example, a polyalkylene glycol macromolecule polymer is used and, generally the polymer of molecular weight 15,000-30,000 is desirable.

(E) Washing disposition top agent : this washing disposition top agent acts also as an adjuvant for the improvement in dispersibility of an abrasive grain. For example, polyethylene-glycol block polymer is used and the thing of molecular weight 40-60 is usually used.

(F) Coefficient-of-friction fall agent : the above-mentioned (C) higher fatty acid acts also as a coefficient-of-friction fall agent.

(G) Use rust-proofing force adjuvant: (tolyl triazole), for example, benzotriazol. The thing of molecular weight of 110-140 is desirable.

(H) Washing disposition top adjuvant : tripropyllene glycol monomethyl ether is used as glycol ether.

(I) -- defoaming agent: -- the fizz of said component (D) and (E) is suppressed, and the thing of a silicone resin system was used.

(J) Purified water (the main raw material) : act as an ionizing solvent for ionizing each raw material.

[0013] The cutting fluid of this invention is manufactured in the following procedures. That is, the distributed condition of said bentonite is further equalized by adding inorganic and/or organic bentonite to purified water (for example, ion exchange water),

making it **** and distribute enough, adding alkanolamine to these dispersion liquid, and making these dispersion liquid into alkalinity. Next, add a higher fatty acid, it is made to react with alkanolamine, and a fatty-acid amine is made to form. After this reaction advances enough, a kind or two or more sorts are chosen as arbitration from from among said water retention improver, a washing disposition top agent, a coefficient-of-friction fall agent, a rust-proofing force adjuvant, a washing disposition top adjuvant, a defoaming agent, etc., and it adds, and considers as a finished product.

[0014] Although water-soluble cutting fluid itself is well-known conventionally, coefficient of friction is high and the conventional thing is not enough as lubricity, in surface tension is high and being inferior to permeability. Moreover, the rust-proofing force is not only also insufficient, but there was a fault that the amount of liquid tends to evaporate. On the other hand, while the water-soluble cutting fluid of this invention cancels the fault of the above-mentioned conventional thing by harnessing the potential property of each constituent, one of the descriptions is in the point which canceled the foamability which is the advantage of the fatty acid which is one of the constituents, and is also demerit by making it change to a fatty-acid amine.

[0015] The cutting fluid of this invention makes this mix and distribute an abrasive grain, is used for it, and although it is effective in especially cutting of the ingot which consists of a silicon single crystal or polycrystal, it is widely applicable also to cutting of **, such as a compound semiconductor or a ceramic. Moreover, the multi-wire saw and multi-band saw which multiplexed a wire saw, a band saw, and these as cutting equipment with which this cutting fluid is used are contained. Furthermore, it can divert also to the cutting equipment of a peripheral cutting edge or an inner circumference cutting edge.

[0016] The raw material component of the cutting fluid of this invention with which is actually manufactured and use is presented, and its presentation are as being standardly shown in [Table 1].

[0017]

[Table 1]

成分		重量%
(A) 無機および/または有機ベントナイト		1.0 ～2.0
(B) アルカノールアミン	トリエタノールアミン	4.0～6.0
(C) 高級脂肪酸	オレイン酸	5.0～8.0
(D) 保水性向上剤	ポリアルキレングリコール高分子重合体	22.0～26.0
(E) 洗浄性向上剤・分散剤	ポリエチレングリコールブロックポリマー	3.0～5.0
(F) 摩擦係数低下剤	特に添加せず（高級脂肪酸がその機能を有す）	―――
(G) 防錆力補助剤	ベンゾトリアゾール	0.1 ～0.3
(H) 洗浄性向上補助剤	トリプロピレングリコールモノメチルエーテル	3.0 ～5.5
(I) 消泡剤	シリコーン樹脂系	0.01～0.1
(J) 精製水		55.0～60.0

[0018]
[Example] The example of this invention and the example of a comparison by conventional cutting oil are explained below.
an example 1 and the example 1 of a comparison -- the raw material component and rate which constitute the cutting fluid (1) of this example are as being shown in [Table 2].
[0019]
[Table 2]

成分		重量%
(A) 無機および/または有機ベントナイト		1.63
(B) アルカノールアミン	トリエタノールアミン	4.70
(C) 高級脂肪酸	オレイン酸	6.10
(D) 保水性向上剤	ポリアルキレングリコール高分子重合体	25.34
(E) 洗浄性向上剤・分散剤	ポリエチレングリコールブロックポリマー	4.08
(F) 摩擦係数低下剤	特に添加せず（高級脂肪酸がその機能を有す）	———
(G) 防錆力補助剤	ベンゾトリアゾール	0.21
(H) 洗浄性向上補助剤	トリプロピレングリコールモノメチルエーテル	4.08
(I) 消泡剤	シリコーン樹脂系	0.01
(J) 精製水		53.85
合計		100.00

[0020] When the physical properties of the water-soluble cutting fluid (1) of above-mentioned this invention and the nonaqueous solubility cutting oil (2) of the conventional example are shown, it is as in [Table 3].

[0021]

[Table 3]

	切削液（1） （本発明）	切削油（2） （従来例）
比重　25℃	1．028±3％	0．894
粘度　25℃（m・Pa・S）	115±3％	80～100
PH　25℃	8．72±3％	—
表面張力（dyn／cm）	32．0±3％	31．8
引火点（℃） （クリーブランド開放式）	なし （100℃で沸騰）	166±10
摩擦係数	0．105～ 0．106	0．092～ 0．100

[0022] Using the slurry which mixes and distributed the above-mentioned cutting fluid (1), cutting oil (2), and an abrasive grain (being a SiC abrasive grain GC** 600, 19-20 micrometers of diameters of an average abrasive grain) at a rate of 1.0-1.5l. : 1.5kg, the wire size set to 3.0kgf(s) tension of the multi-wire saw which is 0.18mm, and cut the ingot of a silicon single crystal in the slice article with a thickness of 0.75mm by cutting speed 1 mm/min.

[0023] Consequently, when the cutting fluid (1) of an example 1 was used, in the ingot with a diameter of 6 inches, all the curvatures (maximum of the difference of the height of the center section which deformed into convex, and the periphery section) of a slice article were set to 10 micrometers or less, and, as for the curvature of a slice article, all of 100 sheets were set to 20 micrometers or less in the ingot with a diameter of 8 inches. On the other hand, when the cutting oil (2) of the example 1 of a comparison was used, in the ingot with a diameter of 6 inches, as for the curvature of a slice article, 98 sheets were set to 10 micrometers or less among 100 sheets, and, as for the curvature of a slice article, 98 sheets were set to 20 micrometers or less among 100 sheets in the ingot with a diameter of 8 inches. Thus, the cutting result equivalent to conventional nonaqueous solubility cutting oil was able to be obtained with the water-soluble cutting fluid of this invention.

[0024]

[Effect of the Invention] By the above explanation, according to the cutting fluid of this invention, there is effectiveness which is a high speed on a par with the case of conventional cutting oil about ingots, such as a silicon single crystal of a major diameter, and can be cut, without making a slice article generate big curvature so that clearly.

Moreover, since the cutting fluid of this invention is water solubility, the danger of the fire by ignition can wash the cutting fluid which there is not and adheres to the obtained slice article by rinsing, and is convenient. Moreover, in processing of washing wastewater, it is possible to use established facilities for drainage, and since processing of the slurry with which cutting was presented can be performed similarly, there is effectiveness, like a fear of causing air pollution unlike the case where the penetrant remover of the conventional organic solvent system is used also disappears.

[Translation done.]

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TECHNICAL FIELD

[Industrial Application] This invention relates to cutting fluid (water-soluble cutting fluid) effective in cutting of ingots, such as a silicon single crystal, polycrystal, other compound semiconductors, and a ceramic, its manufacture approach, and the cutting process of the ingot using this cutting fluid.

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PRIOR ART

[Description of the Prior Art] Conventionally, as cutting fluid for ingot cutting of a silicon single crystal etc., the nonaqueous solubility cutting oil which uses straight mineral oil as a principal component is mainly used, and the slice of an ingot is performed by supplying the cutting fluid (slurry) which made this cutting oil mix and distribute abrasive grains, such as SiC, to the cutting section of an ingot. And degree process is presented with this slice article through a washing process. Moreover, the slurry after being used for cutting of an ingot is processed as trash.
[0003] Washing of said slice article removes the cutting oil adhering to this etc., and the things (for example, trichloroethane, a methylene chloride, etc.) of an organic solvent system have been conventionally used as a penetrant remover. According to the penetrant remover of this organic solvent system, there is an advantage to which washing becomes easy.
[0004] Moreover, as a processing implement for the above-mentioned ingot cutting, the peripheral cutting edge, the inner circumference cutting edge, the band saw, or the wire saw is used. in this case, the diameter of 3 inches or more -- a wire saw and a band saw are comparatively used abundantly at cutting of the ingot of a major diameter. the processing implement of others [reason / the] -- comparing -- more -- homogeneity thickness -- an ingot -- being sliceable -- the yield of cutting waste -- being few -- not only ending -- at once -- many -- it is because several wafers can be cut.

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EFFECT OF THE INVENTION

[Effect of the Invention] By the above explanation, according to the cutting fluid of this invention, there is effectiveness which is a high speed on a par with the case of conventional cutting oil about ingots, such as a silicon single crystal of a major diameter, and can be cut, without making a slice article generate big curvature so that clearly. Moreover, since the cutting fluid of this invention is water solubility, the danger of the fire by ignition can wash the cutting fluid which there is not and adheres to the obtained slice article by rinsing, and is convenient. Moreover, in processing of washing wastewater, it is possible to use established facilities for drainage, and since processing of the slurry with which cutting was presented can be performed similarly, there is effectiveness, like a fear of causing air pollution unlike the case where the penetrant remover of the conventional organic solvent system is used also disappears.

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TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] However, the cutting oil which uses straight mineral oil as a principal component is the dangerous substance with inflammability, and since the penetrant remover of the above-mentioned organic solvent system becomes the cause of main of a ** gun or air pollution (destruction of an ozone layer), use is forbidden recently. Moreover, as for said slurry, it is common that incineration processing is carried out as trash after cutting is presented, and this incineration also causes [one] air pollution. For this reason, it waited for development of that substitute.
[0006] Furthermore, become easy to generate "curvature" in the slice article which was obtained with increase of cutting speed in ingot cutting (the center section of the slice article becomes convex). In the case of a wire saw, when a silicon single crystal ingot with a diameter of 6 inches is cut with 1 or more mm/min of cutting speed, curvature may exceed 10 micrometers. Such big curvature While becoming a failure when carrying out manufacture processing of the silicon wafer etc., it is also the cause that the yield falls, as a result.
[0007] This invention solves the above-mentioned conventional trouble by making cutting fluid into water solubility. That is, the purpose of this invention is to reduce the curvature of the slice article when cutting the silicon single crystal ingot of a major diameter etc. while solving many problems, such as the danger of ignition in the case of using conventional nonaqueous solubility cutting oil, and air pollution accompanying use of the organic solvent in a cut material washing process.

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MEANS

[Means for Solving the Problem] Cutting fluid according to claim 1 is characterized by containing a homogeneous mixture with the fatty-acid amine to which either [at least] organic bentonite or an inorganic bentonite water, and alkanolamine and a higher fatty acid are made to come to react as a principal component.
[0009] Cutting fluid according to claim 2 is characterized by consisting of a kind or two or more sorts of adjuvants chosen as arbitration from the group which serves as said principal component from a water retention improver, a washing disposition top agent, a coefficient-of-friction fall agent, a rust-proofing force adjuvant, a washing disposition top adjuvant, and a defoaming agent in claim 1.
[0010] It faces manufacturing cutting fluid according to claim 1, either [at least] organic bentonite or an inorganic bentonite is added in water, **** distribution is carried out, and the manufacture approach of cutting fluid according to claim 3 adds alkanolamine to these dispersion liquid, and is characterized by alkalinity, nothing, and adding a higher fatty acid to these dispersion liquid further, making this higher fatty acid and alkanolamine react, and making with a fatty-acid amine.
[0011] Cutting process of an ingot according to claim 4 is characterized by slicing ingots, such as a silicon single crystal, by the wire saw or the band saw, using the dispersion liquid which made cutting fluid according to claim 1 or 2 distribute an abrasive grain as a cutting fluid (slurry).
[0012] The cutting fluid of this invention contains the fatty-acid amine to which make a bentonite, water, and alkanolamine and a higher fatty acid come to react as an indispensable constituent, and, generally is constituted by the combination of the following main raw material and various adjuvants.
(A) -- inorganic and organic bentonite (main raw material): -- it is the dispersibility improver (sedimentation inhibitor) of cross-linking, and is for raising the dispersibility of an abrasive grain.

(B) Alkanolamine (the main raw material) : while it is the main raw material of this cutting fluid, act also as a rust-proofing force adjuvant. Usually, triethanolamine was used as a with a molecular weight of 140 or more thing here.
(C) Higher fatty acid (the main raw material) : while it is the main raw material of this cutting fluid, act also as a coefficient-of-friction fall agent (lubrication disposition top agent). Usually, the thing of 90 % of the weight or more of contents of unsaturated fatty acid was used, and oleic acid was used here.
(D) Water retention improver : act as an adjuvant for supplementing with the water retention improver of this cutting fluid, and lubricity. For example, a polyalkylene glycol macromolecule polymer is used and, generally the polymer of molecular weight 15,000-30,000 is desirable.
(E) Washing disposition top agent : this washing disposition top agent acts also as an adjuvant for the improvement in dispersibility of an abrasive grain. For example, polyethylene-glycol block polymer is used and the thing of molecular weight 40-60 is usually used.
(F) Coefficient-of-friction fall agent : the above-mentioned (C) higher fatty acid acts also as a coefficient-of-friction fall agent.
(G) Use rust-proofing force adjuvant: (tolyl triazole), for example, benzotriazol. The thing of molecular weight of 110-140 is desirable.
(H) Washing disposition top adjuvant : tripropyllene glycol monomethyl ether is used as glycol ether.
(I) -- defoaming agent: -- the fizz of said component (D) and (E) is suppressed, and the thing of a silicone resin system was used.
(J) Purified water (the main raw material) : act as an ionizing solvent for ionizing each raw material.
[0013] The cutting fluid of this invention is manufactured in the following procedures. That is, the distributed condition of said bentonite is further equalized by adding inorganic and/or organic bentonite to purified water (for example, ion exchange water), making it **** and distribute enough, adding alkanolamine to these dispersion liquid, and making these dispersion liquid into alkalinity. Next, add a higher fatty acid, it is made to react with alkanolamine, and a fatty-acid amine is made to form. After this reaction advances enough, a kind or two or more sorts are chosen as arbitration from from among said water retention improver, a washing disposition top agent, a coefficient-of-friction fall agent, a rust-proofing force adjuvant, a washing disposition top adjuvant, a defoaming agent, etc., and it adds, and considers as a finished product.
[0014] Although water-soluble cutting fluid itself is well-known conventionally, coefficient of friction is high and the conventional thing is not enough as lubricity, in surface tension is high and being inferior to permeability. Moreover, the rust-proofing

force is not only also insufficient, but there was a fault that the amount of liquid tends to evaporate. On the other hand, while the water-soluble cutting fluid of this invention cancels the fault of the above-mentioned conventional thing by harnessing the potential property of each constituent, one of the descriptions is in the point which canceled the foamability which is the advantage of the fatty acid which is one of the constituents, and is also demerit by making it change to a fatty-acid amine.

[0015] The cutting fluid of this invention makes this mix and distribute an abrasive grain, is used for it, and although it is effective in especially cutting of the ingot which consists of a silicon single crystal or polycrystal, it is widely applicable also to cutting of **, such as a compound semiconductor or a ceramic. Moreover, the multi-wire saw and multi-band saw which multiplexed a wire saw, a band saw, and these as cutting equipment with which this cutting fluid is used are contained. Furthermore, it can divert also to the cutting equipment of a peripheral cutting edge or an inner circumference cutting edge.

[0016] The raw material component of the cutting fluid of this invention with which is actually manufactured and use is presented, and its presentation are as being standardly shown in [Table 1].

[0017]

[Table 1]

成分		重量%
(A) 無機および/または有機ベントナイト		1.0 ～2.0
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(C) 高級脂肪酸	オレイン酸	5.0～8.0
(D) 保水性向上剤	ポリアルキレングリコール高分子重合体	22.0～26.0
(E) 洗浄性向上剤・分散剤	ポリエチレングリコールブロックポリマー	3.0～5.0
(F) 摩擦係数低下剤	特に添加せず（高級脂肪酸がその機能を有す）	―――
(G) 防錆力補助剤	ベンゾトリアゾール	0.1 ～0.3
(H) 洗浄性向上補助剤	トリプロピレングリコールモノメチルエーテル	3.0 ～5.5
(I) 消泡剤	シリコーン樹脂系	0.01～0.1
(J) 精製水		55.0～60.0

[Translation done.]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

EXAMPLE

[Example] The example of this invention and the example of a comparison by conventional cutting oil are explained below.
an example 1 and the example 1 of a comparison -- the raw material component and rate which constitute the cutting fluid (1) of this example are as being shown in [Table 2].
[0019]
[Table 2]

成分		重量%
(A) 無機および/または有機ベントナイト		1.63
(B) アルカノールアミン	トリエタノールアミン	4.70
(C) 高級脂肪酸	オレイン酸	6.10
(D) 保水性向上剤	ポリアルキレングリコール高分子重合体	25.34
(E) 洗浄性向上剤・分散剤	ポリエチレングリコールブロックポリマー	4.08
(F) 摩擦係数低下剤	特に添加せず (高級脂肪酸がその機能を有す)	———
(G) 防錆力補助剤	ベンゾトリアゾール	0.21
(H) 洗浄性向上補助剤	トリプロピレングリコールモノメチルエーテル	4.08
(I) 消泡剤	シリコーン樹脂系	0.01
(J) 精製水		53.85
合計		100.00

[0020] When the physical properties of the water-soluble cutting fluid (1) of above-mentioned this invention and the nonaqueous solubility cutting oil (2) of the conventional example are shown, it is as in [Table 3].

[0021]

[Table 3]

	切削液（1） （本発明）	切削油（2） （従来例）
比重　25℃	1．028±3％	0．894
粘度　25℃（m・Pa・S）	115±3％	80～100
PH　25℃	8．72±3％	—
表面張力（dyn／cm）	32．0±3％	31．8
引火点（℃） （クリーブランド開放式）	なし （100℃で沸騰）	166±10
摩擦係数	0．105～ 0．106	0．092～ 0．100

[0022] Using the slurry which mixes and distributed the above-mentioned cutting fluid (1), cutting oil (2), and an abrasive grain (being a SiC abrasive grain GC** 600, 19-20 micrometers of diameters of an average abrasive grain) at a rate of 1.0-1.5l. : 1.5kg, the wire size set to 3.0kgf(s) tension of the multi-wire saw which is 0.18mm, and cut the ingot of a silicon single crystal in the slice article with a thickness of 0.75mm by cutting speed 1 mm/min.

[0023] Consequently, when the cutting fluid (1) of an example 1 was used, in the ingot with a diameter of 6 inches, all the curvatures (maximum of the difference of the height of the center section which deformed into convex, and the periphery section) of a slice article were set to 10 micrometers or less, and, as for the curvature of a slice article, all of 100 sheets were set to 20 micrometers or less in the ingot with a diameter of 8 inches. On the other hand, when the cutting oil (2) of the example 1 of a comparison was used, in the ingot with a diameter of 6 inches, as for the curvature of a slice article, 98 sheets were set to 10 micrometers or less among 100 sheets, and, as for the curvature of a slice article, 98 sheets were set to 20 micrometers or less among 100 sheets in the ingot with a diameter of 8 inches. Thus, the cutting result equivalent to conventional nonaqueous solubility cutting oil was able to be obtained with the water-soluble cutting fluid of this invention.

[Translation done.]